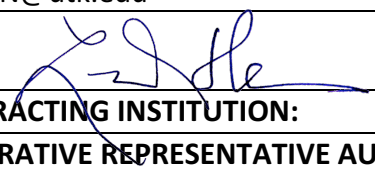
Southeastern Transportation Center
Proposal Cover Page
O/E Grant 2017-2018

UNIVERSITY:	The University of Tennessee	
TITLE OF PROJECT:	Development of a Connected Vehicle Test Bed on UT Campus	
FEDERAL FUNDS:		
Requested Amount	**Proposed Duration:**	**Desired Start Date:**
$49,231	18 months	02.01.2017
MATCHING FUNDS:		
Source 1: GRIDSMART Technologies, Inc.	**Source 2: UTK F&A Reduction**	
$75,500	$9,800	
DEPARTMENT SUBMITTING PROPOSAL:		
PI Name/Title: Lee D. Han/Professor		
Address: 319 John D. Tickle Engineering Building, Knoxville, TN 37996-2313		
Phone: 865.974.7707		
Fax: 865.974.2669		
Email: LHAN@utk.edu		
Signature: 		**Date: 11.04.2016**
SUBCONTRACTING INSTITUTION:		
ADMINISTRATIVE REPRESENTATIVE AUTHORIZED TO CONDUCT NEGOTIATIONS:		
Name/Title:		
Address:		
Phone:		
Fax:		
Email:		
Signature:		**Date:**
ADMINISTRATIVE ORGANIZATION'S REPRESENTATIVE:		
Name/Title:		
Address:		
Phone:		
Fax:		
Email:		
Signature:		**Date:**
OTHER REQUIRED SIGNATURES:		
Name/Title:		
Address:		
Phone:		
Fax:		
Email:		
Signature:		**Date:**

PROBLEM STATEMENT

There are slightly more than a handful of Connected Vehicle (CV) test beds in the U.S. strategically located in Arizona, California, Florida, Michigan, New York, Virginia, etc. As a perennial powerhouse in safety research and advanced technologies, the Southeastern Transportation Center (STC) and its constituent universities would benefit significantly by having an operational CV test bed for facilitating its multitude of research initiatives. To this end, the University of Tennessee teams with the Gridsmart-Denso partnership to propose an exploratory effort towards the development of such an urban/campus environment test bed in Knoxville, TN. Both Gridsmart Technologies and Denso International America, are conveniently located in the metropolitan Knoxville area with prominent worldwide presence. Some of the enabling technologies and scenarios identified for testing in the proposed test bed include:

- DSRC Communication Technologies – Denso International America has developed and manufactured short-range 5.9 GHz radio systems allowing real-time V2x data exchanges. Selected vehicles, potentially including campus transit buses, motor pool vehicles (which are already equipped with OBDII real-time GPS tracking), or eBikes, can be equipped with DSRC radio for communication with one-another and with Gridsmart's infrastructure sensors.
- Sensor Technologies – Denso's onboard data diagnostic system and Gridsmart's single camera traffic monitoring system will be made available to this project by the Gridsmart/Denso partnership. Selected locations on and/or near campus will see deployment of Gridsmart's bell cameras for real-time obstacle detection/warning, adaptive traffic signal control, and potentially dynamic map updating.
- Signal Control – With real-time moving obstacle detection capabilities, dilemma zones cold be avoided and green time could be extended dynamically to significantly reduce crash probabilities.
- Transit Safety – UT's transit fleet are already equipped with GPS tracking capabilities. Added DSRC 59 GHz communication capability with other vehicles and infrastructural sensors could help test the potential of crash avoidance and demand responsive dispatching.
- Ped/Bike Safety – The proposed deployment of real-time intersection monitoring and ped/bike detection could help alert oncoming connected vehicles, extend signal phase for safety purposes, and directly warn pedestrians and cyclists about imminent crash risks.
- Special Event Traffic Management – During special events such as football games, concerts, and so on, some roads may often be closed and different traffic patterns can lead to operational challenges to connected and autonomous vehicles. While this special conditions could be painstakingly keyed into the dynamic roadway map manually, it would be preferable an automatic mechanism could detect and warn connected vehicles about special events. The live video feed and data from Gridsmart cameras can be evaluated in the proposed test bed for such scenarios.

- Disaster Evacuation and Emergency Management – Emergency and evacuation scenarios often see unexpected traffic demand and abnormal pedestrian/vehicular movements, how to detect irregular situations and communicate with vehicles, pedestrians, cyclists, etc. could be tested in an controlled environment as proposed herein.

While it is infeasible to test all scenarios and technologies within the limited project duration, the list above should provide a reasonable vision of how the proposed test bed may be used for research purposes.

RESEARCH OBJECTIVE

The longer-term objective of the proposed O/E endeavor is to develop an urban/campus environment test bed for the operational management and scenario optimization of connected vehicle technologies as well as smart city initiatives. While the amount of fund and duration for this particular O/E grant would obvious not be sufficient to rival those multi-million-dollar test beds under development in Michigan and California, it is the aim of the proposed exploratory effort to build a public-private and academic consortium with partners and stakeholders with vested interest in the success and prosperity of the Southeast and the State of Tennessee. Tennessee Department of Transportation, the City of Knoxville, the University of Tennessee, Oak Ridge National Laboratory, Denso International America, and Gridsmart Technologies are all such partners.

RESEARCH APPROACH

The proposed work is multifaceted with challenges in bringing together various partners, designing of an urban/campus test bed, actually testing some technologies on the infrastructural side as well as the mobile side, and eventually move the process forward towards bringing a full size test bed into fruition eventually. To this end, six tasks were identified.

Task 1. Consortium Development – A key to the long term realization of the test bed is brining various partners together and securing sustainable research funds following the successful conclusion of the O/E project. Some of the major partners are already identified and will participate with in-kind matching as detailed in this proposal.

Task 2. Test Locations Selection – The University of Tennessee (UT) campus and its surrounding areas provide great opportunities for testing different enabling and emerging CV technologies as well as operational scenarios. We will collaborate with the Gridsmart-Denso partnership and work closely with the City of Knoxville, UT Transit, UT Police, and TDOT to find the most suitable locations and scenarios for subsequent deployments and tests.

Task 3. Technology Deployment – Infrastructure: With the generous in-kind contribution from the Gridsmart-Denso partnership, locales selected in Task 2 will see the deployment of Gridsmart bell cameras for traffic monitoring, obstacle detection, and signal control. The timeliness in detecting unexpected obstacles, e.g., animals, debris, traffic cones, and jaywalkers, is crucial to the subsequent real-time warning and signal control decisions.

Task 4. Technology Deployment – Vehicles: Selected "mobile units", which could include UT's transit fleet, motor pool vehicles, eBikes, or other alternatives depending on the partnership, will be equipped with Denso's DSRC 59 GHz communication device for exchanging warning messages with infrastructural sensors and other vehicles and for coordination in special event scenarios.

Task 5. Field Tests – With the infrastructural and mobile technologies deployed, a number of field tests will be performed and the results studied. These are demonstrated tests for showcasing how the UT campus test bed could be used for CV research.

Task 6. Further Development – The purpose of this study is to develop a fully instrumented and financially solvent CV test bed for advancing STC's safety research agenda and for implementing advanced technologies in our region. Plans will be developed and proposals will be submitted towards this goal.

RESEARCH DURATION AND COST

Depending on when the project could be awarded, we estimate the project to be 12 to 18 months ending before 07.31.2018. The costs will include a Federal share in the amount of $49,231. Cost sharing efforts include in-kind hardware equipment, installation, and use of data from Gridsmart-Denso partnership in the amount of $50,000 plus $25,500 (F&A) and a reduction of UT's F&A rate from 51% to 15% or $9,800. The duration details are provided in the timeline chart to follow.

QUALIFICATIONS OF RESEARCH TEAM

Dr. Lee D. Han will lead this effort in building a consortium, overseeing all aspects of the design and field tests, and eventually move the test bed development forward with long-term plans and subsequent funding proposals. Dr. Han has been responsible for more than $10 millions of research at UT in the capacity of PI or Co-PI in the past two decades. His sponsors include US DOD, US DOE, TN DOT, TN DOS, and other private companies. Recently, Dr. Han has been the awardee of 2016-17 L.R. Hesler Award of Excellence, 2014-15 Chancellor's Citation of Research and Creative Achievement, 2014 College of Engineering Research Achievement Award, 2013 COE Teaching Fellow, and 2012 Leon and Nancy Cole Superior Teaching Award. Dr. Han has over 60 refereed journal publications and hundreds of conference proceeding papers and technical reports.

Other contributing members of this research team include the Gridsmart-Denso partnership. Both companies have strong national and international prominence but at the same time are both local to Knoxville. Their equipment and services are widely used and will be the backbone of this effort.

STUDENT INVOLVEMENT

An advanced doctoral student will be involved in the research aspect of the project. The student will work closely with Gridsmart and Denso to ensure all deployment and subsequent data collection and analysis aspects are conducted per the plan of the proposal. The student will incorporate the effort herein into his/her doctoral research and publish a paper or papers reporting the results of the study. Additional undergraduate students, especially when eBikes are to be used as CV, will be used for testing certain safety and operational aspects that have not been tested at other CV test sites.

TECHNOLOGY TRANSFER

This entire project is a technology transfer effort. The development effort of a CV test bed is intended to transfer Gridsmart's sensor technologies and Denso's mobile communication technologies to the City of Knoxville, the University of Tennessee campus, and TDOT. We expect that the results of the deployment efforts and tests as presented in Tasks 3, 4, and 5 will be reported in transportation journals such as TRR, Transportation Safety and Security, and IEEE Transactions of ITS. The results will also be presented to major stakeholders as identified in the research consortium task. The findings from a smaller urban/campus environment should be valuable since most other CV test beds are for larger areas.

STC Research Schedule/Timeline

Task / Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Consortium Development																		
2. Test Locations Selection																		
3. Tech Deployment – Infrastructure																		
4. Tech Deployment – Vehicles																		
5. Field Tests																		
6. Further Development																		

Project milestones should be listed on this form. Quarterly reports will be compared to them to ensure compliance.
STC Grants must be completed on or before July 31, 2018.

STC Research Project Description

Project Title: Development of a Connected Vehicle Test Bed on UT Campus

Principal Investigator: Lee D. Han
University: The University of Tennessee
Telephone: 865.974.7707 **Email Address:** LHAN@utk.edu

External Project Contact (if applicable): Will Overstreet, Gridsmart Technologies, Inc.
Address Street: 10545 Hardin Valley Road
City: Knoxville **State:** TN **Zip:** 37932
Telephone: 865.482.2112 **Email Address:** will.overstreet@gridsmart.com

Project Start Date: 02/01/2017 **End Date:** 07/31/2018
Other Milestones, Dates:

Project #:

Project Objective:

The longer-term objective of the proposed O/E endeavor is to develop an urban/campus environment test bed for operational management and scenario optimization of connected vehicle technologies as well as smart city initiatives. It is the aim of the proposed exploratory effort to build a public-private and academic consortium with partners and stakeholders with vested interest in the success and prosperity of the Southeast and the State of Tennessee.

Project Abstract:

There are slightly more than a handful of Connected Vehicle (CV) test beds in the U.S. strategically located in Arizona, California, Florida, Michigan, New York, Virginia, etc. As a perennial powerhouse in safety research and advanced technologies, the Southeastern Transportation Center (STC) and its constituent universities would benefit significantly by having an operational CV test bed for facilitating its multitude of research initiatives. To this end, the University of Tennessee teams with the Gridsmart-Denso partnership to propose an exploratory effort towards the development of such an urban/campus environment test bed in Knoxville, TN. Both Gridsmart Technologies and Denso International America, are conveniently located in the metropolitan Knoxville area with prominent worldwide presence. Some of the enabling technologies and scenarios identified for testing in the proposed test bed include:

- DSRC Communication Technologies
- Sensor Technologies
- Signal Control
- Transit Safety
- Ped/Bike Safety
- Special Event Traffic Management
- Disaster Evacuation and Emergency Management

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Total Budget: $ 134,531 ($49,231 from Federal)

Student Involvement (Thesis, Assistantships, Paid Employment):

Paid employment with tuition coverage.

Relationship to Other Projects:

This effort will help STC further its connected vehicle safety research by initiating the development of a CV test bed. It will open up many opportunities beyond the CV technology.

Technology Transfer Activities:

This entire project is a technology transfer effort. The development effort of a CV test bed is intended to transfer Gridsmart's sensor technologies and Denso's mobile communication technologies to the City of Knoxville, the University of Tennessee campus, and TDOT. We expect that the results of the deployment efforts and tests as presented in Tasks 3, 4, and 5 will be reported in transportation journals such as TRR, Transportation Safety and Security, and IEEE Transactions of ITS. The results will also be presented to major stakeholders as identified in the research consortium task. The findings from a smaller urban/campus environment should be valuable since most other CV test beds are for larger areas

Potential Benefits of Project:

Southeastern Transportation Center and Tennessee DOT have wanted to develop a test bed for CV and related technologies. This effort, though with limited funds and scope, will take the first realistic towards establishing a test bed with deployed infrastructural and mobile technologies. The project will also form a consortium of stakeholders with viable plans and proposals developed for sustainable future research activities.

TRB Keywords:

Connected Vehicle, Test Bed, DSRC, Special Event, Ped-Bike, Image Processing, Autonomous Vehicle, Incident management, adaptive signal control, dilemma zone.

PEER REVIEW FORM

Peer Reviewer #1

Name:	
Organization/University Affiliation:	
Address:	
Phone #:	
Fax #:	
Email address:	
Please submit a brief overview of why this individual is qualified to review the material.	
Qualifications of reviewer:	

Peer Reviewer #2

Name:	
Organization/University Affiliation:	
Address:	
Phone #:	
Fax #:	
Email address:	
Please submit a brief overview of why this individual is qualified to review the material.	
Qualifications of reviewer:	

Peer Reviewer #3

Name:	
Organization/University Affiliation:	
Address:	
Phone #:	
Fax #:	
Email address:	
Please submit a brief overview of why this individual is qualified to review the material.	
Qualifications of reviewer:	

*Two peer reviewers will be selected for each final report. Other appropriate reviewers may be selected at the discretion of the STC.

Southeastern Transportation Center
Proposed Budget
O/E Grant 2017-2018

Title: **Development of a Connected Vehicle Test Bed on UT Campus**

University: **The University of Tennessee**

		Federal Funds	Matching Funds
Salaries:		$11,469	
	Faculty		
	Administrative Staff		
	Other Staff		
	Graduate Student Salaries/Stipends	$11,100	
	Undergraduate Student Salaries/Stipends		
	Total Salaries/Stipends	$22,569	
	Benefits (including student health insurance)	$4,655	
	Total Salaries and Benefits	**$27,224**	
Other Direct Costs:			
	Permanent Equipment		
	Expendable Equipment/Supplies/Data		$50,000
	Non-salary Education Costs – tuition/fees	$8,123	
	Other Costs: (specify)		
	Printing / duplication		
	Postal expense		
	Communication		
	Conference Registration / Fees		
	Travel		
	Computer Costs		
	Other miscellaneous costs:		
	Total Other Direct Costs	**$8,123**	
	Indirect Costs at 51%	**$13,884**	**$35,300**
TOTAL COSTS		**$49,231**	**$85,300**

Lee D. Han

Department of Civil and Environmental Engineering
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web.utk.edu/~lh *lhan@utk.edu*

EDUCATION

1991	PH.D.	Department of Civil Engineering, Transportation Group, with minors in IEOR and Statistics, University of California at Berkeley, Berkeley, California. Dissertation Title: "*Traffic Flow Characteristics of Signalized Arterials Under Disturbance Situations*"
1987	M.SC.	Department of Civil Engineering, Transportation Division, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Thesis Title: "*Decision Support Systems for Mass Evacuation and Emergency Management*"
1985	B.SC.	Department of Civil Engineering, National Taiwan University, Taipei, Taiwan. Thesis Title: "*Computer Aided Design - Algorithms and Applications*"

RECENT EXPERIENCE

- PROFESSOR WITH TENURE, Civil & Environmental Engineering, UNIVERSITY OF TENNESSEE
- CHAIR, RESEARCH Council, UNIVERSITY OF TENNESSEE Faculty Senate, 2011~2013
- COORDINATOR, Transportation Engineering Program, CEE, UNIVERSITY OF TENNESSEE, 2010~2013

RECENT JOURNAL PAPERS

1. Zhang[+], Y. and L.D. Han* (2017) "*Enhancing Relative Positioning Accuracy in V2V Safety Applications Using Multi-Vehicle Kinematics and Nonlinear Filtering*." Transportation Research Record, National Research Council, Washington, D.C. (accepted) {SCI}
2. Zhang[+], Y., Y. Liu, and L.D. Han* (2017) "*Real-Time Piecewise Regression and Its Application in Effective and Economical GPS Trajectory Data Collection*." Transportation Research Record, National Research Council, Washington, D.C. (accepted) {SCI}
3. Hargrove[+], S., H. Lim, and L.D. Han (2016) "*Enhancement to Self-Learning License Plate Matching Algorithm: Derived Association Matrices*." Transportation Research Record, 2594, National Research Council, Washington, D.C. {SCI}
4. Hargrove[+], S., H. Lim, P. Freeze, and L.D. Han (2016) *"Empirical Study of the Evaluation of Travel Speed Data Accuracy."* Transportation Research Record, National Research Council, Washington, D.C. (in press) {SCI}
5. Khatri, R., C.R. Cherry, S.S. Nambisan, and L.D. Han (2016) "*Route Choice Model for Bike Share Users from Real-Time GPS Data.*" Transportation Research Record, National Research Council, Washington, D.C. (in press) {SCI}
6. Lu[+], W., C. Liu, N. Thomas, B.L. Bhaduri, and L.D. Han (2015) "*Global System for Transportation Simulation and Visualization in Emergency Evacuation Scenarios*," Transportation Research Record, 2529:46-55, National Research Council. {SCI}
7. Yang[+], J., L.D. Han*, P.B. Freeze, S. Chin, and H. Hwang (2015) "*Short-Term Freeway Speed Profiling Based on Longitudinal Spatial-Temporal Dynamics*," Transportation Research Record, Network Modeling Vol.2, 2467:62-72, National Research Council. {SCI}
8. Lu[+], W. and L.D. Han (2015) "*Impacts of Vehicular Communication Networks on Traffic Dynamics and Fuel Efficiency*," Chapter 7 of ICT for Transport: Opportunities and Threats, 161-178, ISBN 978-1-78347-129-4, Edward Elgar Publishing. {SCI}
9. Han, L.D., S. Nambisan, E.L. Lemons, and C.R. Cherry (2015) "*Fair Representation of Transportation Research Record's Impacts: a Case Study on Journal Citation Reports' Impact Factor*," Transportation Research Record, 2480:1-10, National Research Council. {SCI}
10. Yang, Q.[+], R. Overton, L.D. Han, X. Yan, S.H. Richards (2014) "*Driver Behaviors on Rural Highways with and without Curbs - a Driving Simulator Based Study*," International Journal of Injury Control and Safety Promotion, 21(2):115-126. {SCI}
11. Ji., S., C.R. Cherry, L.D. Han, S. Worley, and D. Jordan (2014) "*Electric Bike Sharing: Simulation of User Demand and System Availability*," Cleaner Production, 85:250-257. {SCI}

[+] Dr. Han's advisee
* as Corresponding Author

12. Dong, C., C. Shao, S.H. Richards, and L.D. Han (2014) "*Flow Rate and Time Mean Speed Predictions for the Urban Freeway Network using State Space Models*," Transportation Research Part C – Emerging Technologies, 43:20-32. {SCI}
13. Oliveira-Neto[+], F.M., L.D. Han*, and M.K. Jeong (2014) "*An Online Self-Learning Algorithm for License Plate Matching*," IEEE Transactions on Intelligent Transportation Systems, 14(4):1806-1816. {SCI}
14. Lu[+], W., L.D. Han*, C. Liu, and K. Long (2014) "*A Multiple-Source-Nearest-Destination Shortest Path Problem in Evacuation Assignment*," Safe Smart and Sustainable Multimodal Transportation Systems – Proceedings of the 14th COTA International Conference of Transportation Professionals, 3691-3702, ASCE. {EI}
15. Yang[+], Q., L.D. Han*, and C. Cherry (2013) "*Some Measure for Sustaining Red-Light Camera Programs and Their Negative Impacts*," Transport Policy, 29:192-198. {SCI}
16. Bogdanovic, V., N. Ruskic, M. Kulovic, and L.D. Han* (2013) "*Toward a Capacity Analysis Procedure for Non-Standard TWSC Intersections*," Transportation Research Record 2395:132-138. {SCI}
17. Li[+], J., L.D. Han, and C. Chen. (2013) "*Impact of Data Resolution on Peak-Hour Factor Estimation for Transportation Decisions*," Central European Journal of Engineering, 3(4):732-739. {Scopus}
18. Fang, Z., Q. Li, Q. Li, L.D. Han, and S. Shaw (2013) "*A Space Time Efficiency Model for Optimizing Intra-Intersection Vehicle-Pedestrian Evacuation Movements*," Transportation Research Part C – Emerging Technologies, 30:112-130. {SCI}
19. Sun, X., T. Urbanik II, and L.D. Han (2013) "*Neurofuzzy Control to Actuated-Coordinated System at Closely-Spaced Intersections*," Applied Mechanics and Materials, 321:1249-1258. {SCI}
20. Lu[+], W., L.D. Han, and C.R. Cherry (2013) "*Evaluation of Vehicular Communication Networks in a Car Sharing System*," International Journal of Intelligent Transportation Systems Research, 11:113-119. {EI}
21. Williamson, J.M., J.W. Lounsbury, and L.D. Han (2013) "*Key Personality Traits of Engineers for Innovation and Technology Development*," Journal of Engineering and Technology Management, 30(2):157-168, Elsevier. {SCI}
22. Long, K., Y. Liu, and L.D. Han* (2013) "*Impact of Countdown Timer on Driving Maneuvers after the Yellow Onset at Signalized Intersections: an Empirical Study in Changsha, China*," Safety Science, 54:8-16. {SCI}
23. Yang, Q.[+], R. Overton, L.D. Han*, X. Yan, and S.H. Richards (2013) "*The Influence of Curbs on Driver Behaviors in Four-Lane Rural Highways - a Driving Simulator Based Study*," Accident Analysis & Prevention, 50:1289-97. {SCI}

Recent Sponsored Research

2016 ~ 2018	*PI, Automated Plate Recognition and Truck Trip Tracking, TDOT (approved and in process of contracting)*	*$99K*
2016 ~ 2018	*PI, End of Queue Prediction and Protection, TDOT*	*$121K*
2016 ~ 2017	*PI, Energy and Freight Transportation Planning, UT-Battelle/ORNL*	*$120K*
2015 ~ 2017	*PI, Tennessee SHRP2 Travel-Time Reliability Tools Implementation, SHRP2/FHWA*	*$350K*
2015 ~ 2016	*PI, Energy and Transportation Statistics and Freight Analysis, UT-Battelle/ORNL*	*$121K*
2015	*PI, Passenger and Freight Transportation Policy Analysis, UT-Battelle/ORNL*	*$39K*
2014 ~ 2016	*CoPI, Major Research Initiatives, Southeastern Transportation Center, RITA/USDOT*	*$750K*
2013 ~ 2014	*PI, Transportation Energy Statistics, UT-Battelle/ORNL*	*$79K*
2013 ~ 2014	*PI, Interstate Travel Time Study - Analysis, TDOT*	*$176K*
2013	*PI, High Performance Traffic Simulation Tasks for Emergency Management - Phase II, UT-Battelle/ORNL*	*$30K*
2013	*PI, Interstate Travel Time Study - Acquisition & Preparation, TDOT*	*$74K*
2012 ~ 2013	*PI, Transportation Security & Energy Efficiency Research V, UT-Battelle/ORNL*	*$136K*
2012 ~ 2013	*PI, High Performance Traffic Simulation Tasks for Emergency Management, UT-Battelle/ORNL*	*$82K*
2012	*PI, Large-Scale Distributed Traffic Simulation and Data System - Year 2, Science Alliance JDRD Grant*	*$55K*
2012	*PI, Transportation Security & Energy Efficiency Research IV, UT-Battelle/ORNL*	*$54K*
2011 ~ 2012	*PI, EVE Algorithm Enhancement using HCM 2010, TDOT*	*$134K*
2011 ~ 2012	*Co-PI, Modeling the Impact of the Emerging Bioeconomy on Transportation Network Flows with Simulation, Sun Grant, USDOT*	*$60K*
2011 ~ 2012	*PI, Transportation Security & Energy Efficiency Research III, UT-Battelle/ORNL*	*$65K*
2011 ~ 2012	*PI, Large-Scale Distributed Traffic Simulation and Data System - Year 1, Science Alliance JDRD Grant*	*$52K*
2010 ~ 2013	*PI, Incorporation of Economic Factors in TDOT Needs Assessment, TDOT*	*$84K*
2010 ~ 2011	*PI, Real-Time Truck Tracking for Safety and Security, NTRC-RITA-USDOT*	*$175K*
2010 ~ 2012	*PI, Incorporation of Economic Factors into TDOT-FHWA*	*$85K*